

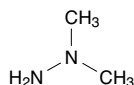
1,1-Dimethylhydrazine

CAS No. 57-14-7

Reasonably anticipated to be a human carcinogen

First listed in the *Fourth Annual Report on Carcinogens* (1985)

Also known as unsymmetrical dimethylhydrazine or UDMH



Carcinogenicity

1,1-Dimethylhydrazine is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Oral exposure of mice to 1,1-dimethylhydrazine caused tumors at several different tissue sites. Following administration of 1,1-dimethylhydrazine in drinking water, high incidences of blood-vessel cancer (angiosarcoma) in various organs were observed in mice of both sexes; tumors of the kidneys, lungs, and liver also were observed. Administration of 1,1-dimethylhydrazine by stomach tube increased the incidence of lung tumors and the number of tumors per animal in female mice (IARC 1974).

Since 1,1-dimethylhydrazine was listed in the *Fourth Annual Report on Carcinogens*, additional studies in experimental animals have been identified. 1,1-Dimethylhydrazine administered by subcutaneous injection increased the incidence of benign and malignant peripheral nerve sheath tumors (neurofibrosarcoma and melanotic and unpigmented schwannoma) in hamsters of both sexes (IARC 1999).

Cancer Studies in Humans

No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to 1,1-dimethylhydrazine.

Properties

1,1-Dimethylhydrazine exists at room temperature as a clear, colorless liquid with a fishy odor. It is miscible with water, ether, hydrocarbons, and dimethylformamide and is very soluble in methanol and ethanol (HSDB 2009). It is stable under normal temperatures and pressures, but is considered very flammable and can be ignited easily (Akron 2009). Physical and chemical properties of 1,1-dimethylhydrazine are listed in the following table.

Property	Information
Molecular weight	60.1
Specific gravity	0.78 at 25°C/25°C
Melting point	-58°C
Boiling point	64°C at 760 mm Hg
Log K_{ow}	-1.19
Water solubility	1,000 g/L
Vapor pressure	167 mm Hg at 25°C
Vapor density relative to air	1.94
Dissociation constant (pK_a)	7.21 at 25°C

Source: HSDB 2009.

Use

1,1-Dimethylhydrazine is used primarily as a component of jet and rocket fuels. Other uses include as an intermediate for chemical synthesis, as a stabilizer for organic peroxide fuel additives, as an

absorbent for acid gases, as a plant growth control agent, and in photography (ATSDR 1997, IARC 1999, HSDB 2009).

Production

Production of 1,1-dimethylhydrazine was first reported to the U.S. Tariff Commission in 1956 (IARC 1974). Production was 45 metric tons (99,000 lb) in 1977 and 4.5 metric tons (9,900 lb) in 1982 (ATSDR 1997, HSDB 2009). In 2009, 1,1-dimethylhydrazine was produced by four manufacturers worldwide, including one in the United States (SRI 2009), and was available from 17 suppliers, including 9 U.S. suppliers (ChemSources 2009). Reports filed under the U.S. Environmental Protection Agency's Toxic Substances Control Act Inventory Update Rule indicated that U.S. production plus imports of 1,1-dimethylhydrazine totaled 500,000 pounds to 1 million pounds in 1986, 1990, and 1994 and 10,000 to 500,000 lb in 1998 and 2002 (EPA 2004).

Exposure

The primary routes of potential human exposure to 1,1-dimethylhydrazine are inhalation, ingestion, and dermal contact (HSDB 2009). The general population potentially could be exposed by ingestion of residues present on foods treated with 1,1-dimethylhydrazine. In the past, humans have been exposed to 1,1-dimethylhydrazine following ingestion of fruits sprayed with the plant growth regulator Alar (daminozide). 1,1-Dimethylhydrazine was identified as a hydrolysis product of daminozide in processed fruit. Daminozide is no longer registered for use on food plants in the United States (ATSDR 1997). 1,1-Dimethylhydrazine has been detected in tobacco products (at concentrations of up to 147 ng/g); therefore, people who chew tobacco may be exposed to small amounts of 1,1-dimethylhydrazine (Schmeltz *et al.* 1977). However, it has been detected in cigarette mainstream smoke (Diekmann *et al.* 2002). The potential for exposure to 1,1-dimethylhydrazine may be higher for people who live near military installations where the chemical is used as an aerospace propellant or for people who live near hazardous-waste sites contaminated with hydrazines. In the mid 1970s, 1,1-dimethylhydrazine was measured in the air near Rocky Mountain Arsenal at levels of up to 1.7 ppm (4.1 mg/m³) (limit of detection = 0.001 ppm [0.002 mg/m³]) (HSDB 2009). In 1997, 1,1-dimethylhydrazine was identified as a contaminant at three hazardous-waste sites on EPA's National Priorities List.

Environmental exposure to 1,1-dimethylhydrazine is expected to be very low, because it degrades rapidly in the environment (HSDB 2009). Between 1988 and 2007, the largest environmental release of 1,1-dimethylhydrazine reported by EPA's Toxics Release Inventory occurred in 1988, when 13,188 lb was released, predominantly to on-site landfills or surface impoundments and to air. Since 1988, the largest releases have been 2,320 lb in 1989 and 1,468 lb in 2001. The smallest reported release occurred in 2007, when one U.S. facility released 15 lb of 1,1-dimethylhydrazine, including 5 lb to air and 10 lb to an off-site hazardous-waste landfill (TRI 2009). If released to air, 1,1-dimethylhydrazine will exist entirely in the vapor phase and will react quickly with ozone, with a half-life of about 16.5 minutes, or with hydroxyl radicals, with an estimated half-life of 6 days. 1,1-Dimethylhydrazine has not been detected in environmental samples of water or soil (HSDB 2009).

Workers may potentially be exposed to 1,1-dimethylhydrazine during its production, transportation, use as a chemical intermediate, or application to control the growth of crops and vegetation, especially if proper protective equipment is not used (ATSDR 1997). Greenhouse workers who use daminozide on non-food plants may be exposed to small amounts of 1,1-dimethylhydrazine (ATSDR 1997). The National Occupational Exposure Survey (conducted from 1981

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to 1983) estimated that 2,917 workers (in the Chemicals and Allied Products industry) potentially were exposed to 1,1-dimethylhydrazine (NIOSH 1990).

Regulations

Department of Transportation (DOT)

1,1-Dimethylhydrazine is considered a hazardous material and marine pollutant, and special requirements have been set for marking, labeling, and transporting this material.

Environmental Protection Agency (EPA)

Clean Air Act

National Emissions Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

New Source Performance Standards: Manufacture or use of 1,1-dimethylhydrazine is subject to certain provisions for the control of volatile organic compound emissions.

Prevention of Accidental Release: Threshold quantity (TQ) = 15,000 lb.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 10 lb.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Reportable quantity (RQ) = 10 lb.

Threshold planning quantity (TPQ) = 1,000 lb.

Resource Conservation and Recovery Act

Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of 1,1-dimethylhydrazine = U098, K107, K108, K109, K110.

Listed as a hazardous constituent of waste.

Occupational Safety and Health Administration (OSHA)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2010, specific PELs may not reflect the more current studies and may not adequately protect workers. Permissible exposure limit (PEL) = 0.5 ppm (1 mg/m³).

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.01 ppm.

National Institute for Occupational Safety and Health (NIOSH)

Ceiling recommended exposure limit = 0.06 ppm (0.15 mg/m³) (2-h exposure).

Immediately dangerous to life and health (IDLH) limit = 15 ppm.

Listed as a potential occupational carcinogen.

References

- Akron. 2009. *The Chemical Database*. The Department of Chemistry at the University of Akron. <http://ull.chemistry.uakron.edu/erd> and search on CAS number. Last accessed: 4/28/09.
- ATSDR. 1997. *Toxicological Profile for Hydrazines*. Agency for Toxic Substances and Disease Registry. <http://www.atsdr.cdc.gov/toxprofiles/tp100.pdf>.
- ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International. <http://www.chemsources.com/chemonline.html> and search on dimethylhydrazine. Last accessed: 4/28/09.
- Diekmann J, Biefel C, Rustemeier K. 2002. Analysis of cigarette mainstream smoke for 1,1-dimethylhydrazine and vinyl acetate by gas chromatography-mass spectrometry. *J Chromatogr Sci* 40(9): 509-514.
- EPA. 2004. *Non-confidential IUR Production Volume Information*. U.S. Environmental Protection Agency. <http://www.epa.gov/oppt/iur/tools/data/2002-vol.html> and search on CAS number.
- HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> and search on CAS number. Last accessed: 4/28/09.
- IARC. 1974. 1,1-Dimethylhydrazine. In *Some Aromatic Amines, Hydrazine and Related Substances, N-Nitroso Compounds and Miscellaneous Alkylating Agents*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 4. Lyon, France: International Agency for Research on Cancer. pp. 137-143.
- IARC. 1999. 1,1-Dimethylhydrazine. In *Re-evaluation of Some Organic Chemicals, Hydrazine, and Hydrogen Peroxide*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 71. Lyon, France: International Agency for Research on Cancer. pp. 1425-1436.
- NIOSH. 1990. *National Occupational Exposure Survey (1981-83)*. National Institute for Occupational Safety and Health. Last updated: 7/1/90. <http://www.cdc.gov/noes/noes1/84395sic.html>.
- Schmeltz I, Abidi S, Hoffmann D. 1977. Tumorigenic agents in unburned processed tobacco: N-nitrosodiethanolamine and 1,1-dimethylhydrazine. *Cancer Lett* 2(3): 125-131.
- SRI. 2009. *Directory of Chemical Producers*. Menlo Park, CA: SRI Consulting. Database edition. Last accessed: 4/28/09.
- TRI. 2009. *TRI Explorer Chemical Report*. U.S. Environmental Protection Agency. Last updated: 3/19/09. <http://www.epa.gov/triexplorer> and select 1,1-Dimethyl Hydrazine.